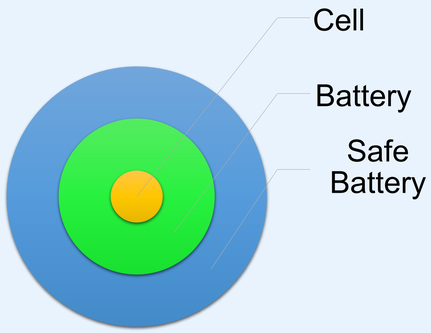
National Aeronautics and Space Administration

Sensor-based Prognostics to Avoid Runaway Reactions & Catastrophic Ignition (SPARRCI)

Ensuring Safe, Reliable Power for Electric Aircraft

Challenge

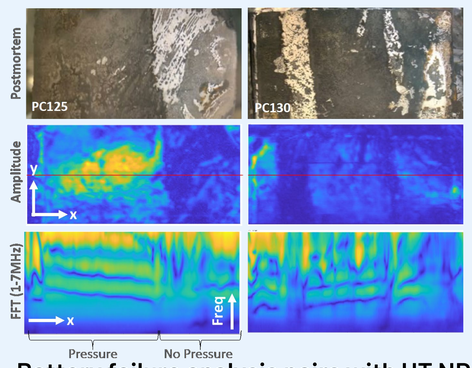
- Electric aircraft concepts require high power and high energy storage, but they must also be SAFE!
- State-of-the-art batteries suffer from catastrophic failures, resulting in over-engineered, heavy failure solutions to provide safer energy storage
- Existing solutions aim to contain or prevent thermal runaway propagation at a battery level, but single-cell events cannot be predicted



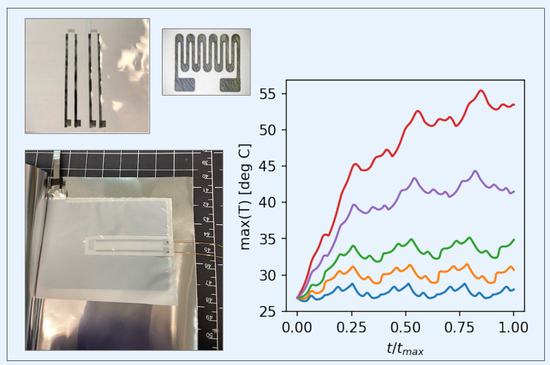
Turning a chemistry into a cell, packaged battery, and safe battery adds layers of mass

Expected Impacts

- With early detection of failure, we ensure catastrophic failures are eliminated and the result is a safe, higher energy battery to enable next-generation electric aircraft concepts
- Next-generation battery chemistry development occurs on a long timeline and may offer higher specific energy but not additional safety
- SPARRCI offers a shorter timeline to implement new chemistries with a better understanding of safety



Battery failure analysis pairs with UT NDE techniques, showing sensitivity to defects



Embedded sensors provide higher quality data to improve fidelity of off-nominal models

SPARRCI offers decreased weight, increased safety, and improved aircraft performance

Solutions

- SPARRCI offers a multi-disciplinary approach combining battery failure analysis, nondestructive evaluation (NDE), sensor development, and modeling & prognostics for early failure detection
- Using embedded sensor and NDE data fed into advanced off-nominal models, failures can be predicted based on changes in cell function or material morphology
- Enabling for higher energy, safer aircraft batteries for existing chemistries and shortening the timeline for future development

Results

- Using shadow mask and photolithography, sensors are printed onto battery materials & provide valuable internal data when embedded in pouch cells
- NDE techniques such as digital radiography and ultrasound, and laser doppler vibrometry can detect material defects
- Advances to battery performance models predict off-nominal behavior

Next Steps

-Demonstrate benefit of data from combined sensor + NDE techniques during nominal and off-nominal cell behavior

- Integrate concepts into battery pack-level NASA projects
- Address optimization of sensor connections, data collection, and modeling/prognostics fidelity

Partners and/or Participants

- NASA Glenn Research Center, batteries/sensors
- NASA Langley Research Center, NDE
- NASA Ames Research Center, modeling & prognostics
- Cornerstone Research Group, small business partner

IMAGINAVIATION

CONVERGENT AERONAUTICS SOLUTIONS

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